

MILITARY SPECIFICATION

SEMICONDUCTOR DEVICE, TRANSISTOR, PNP, GERMANIUM, LOW-POWER

TYPE 2N428

This specification is mandatory for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the detail requirements for a PNP, germanium, low-power switching transistor.

1.2 Physical dimensions. See figure 1 (TO-5).

1.3 Maximum ratings.

PT 1/	V _{CB0}	V _{CEO}	V _{EBO}	I _C	T _{stg}
mW	V _{dc}	V _{dc}	V _{dc}	mAdc	°C
150	-30	-12	-20	400	-65 to +100

1/ Derate linearly 2 mW/°C for T_A > 25° C.

1.4 Primary electrical characteristics.

Limits	f _{hfb} V _{CB} = -5 V _{dc} I _C = -1 mAdc	h _{FE} V _{CE} = -0.25 V _{dc} I _B = -1 mAdc	h _{FE} V _{CE} = -0.35 V _{dc} I _B = -10 mAdc	V _{CE(sat)} I _C = -200 mAdc I _B = -10 mAdc
	MHz			V _{dc}
Min	10	60	20	...
Max	---	250	---	-0.25

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of the specification to the extent specified herein.

SPECIFICATION

MILITARY

MIL-S-19500 - Semiconductor Devices, General Specification for.

STANDARD

MILITARY

MIL-STD-750 - Test Methods for Semiconductor Devices.

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. REQUIREMENTS

3.1 General. Requirements shall be in accordance with MIL-S-19500, and as specified herein.

3.2 Abbreviations, symbols, and definitions. The abbreviations, symbols, and definitions used herein are defined in MIL-S-19500.

3.3 Design, construction, and physical dimensions. Transistors shall be of the design, construction, and physical dimensions shown on figure 1.

3.3.1 Terminal-lead length. Terminal-lead length(s) other than that specified in figure 1 may be furnished when so stipulated under contract or order (see 6.2) where the devices covered herein are required directly for particular equipment-circuit installation or for automatic-assembly-technique programs. Where other lead lengths are required and provided, it shall not be construed as adversely affecting the qualified-product status of the device, or applicable JAN marking.

3.4 Performance characteristics. Performance characteristics shall be as specified in tables I, II, and III.

3.5 Marking. The following marking specified in MIL-S-19500 may be omitted from the body of the transistor at the option of the manufacturer:

- (a) Country of origin.
- (b) Manufacturer's identification.

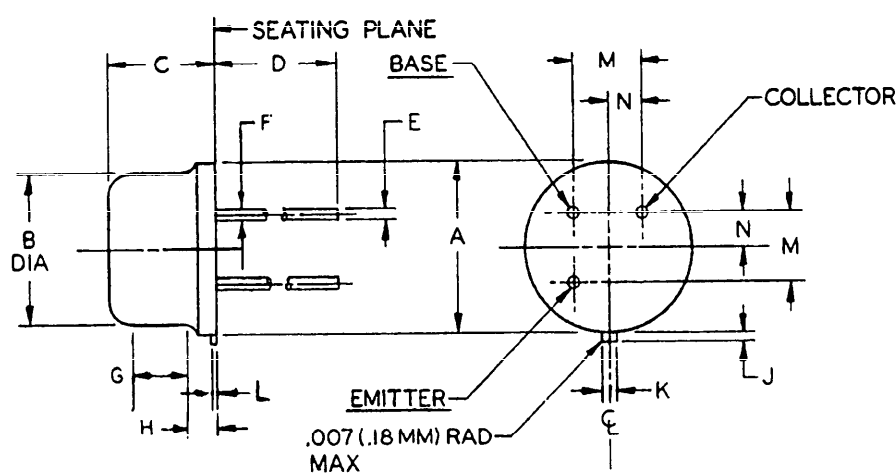
4. QUALITY ASSURANCE PROVISIONS

4.1 Sampling and inspection. Sampling and inspection shall be in accordance with MIL-S-19500, and as specified herein.

4.2 Qualification inspection. Qualification inspection shall consist of the examinations and tests specified in tables I, II, and III.

4.3 Quality conformance inspection. Quality conformance inspection shall consist of group A, B, and C inspections.

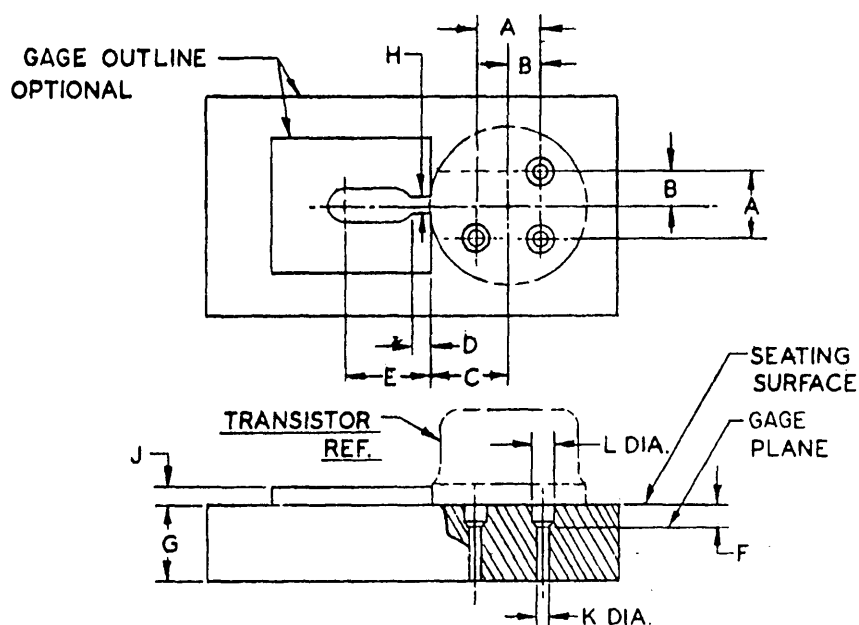
4.3.1 Group A inspection. Group A inspection shall consist of the examinations and tests specified in table I.



DIMENSIONS					NOTES
LTR	INCHES		MILLIMETERS		
	MIN	MAX	MIN	MAX	
A	.335	.370	8.51	9.40	--
B	.305	.335	7.75	8.51	--
C	.240	.260	6.10	6.60	--
D	1.500	1.750	38.10	44.45	9
E	.016	.021	.41	.53	2,9
F	.016	.019	.41	.48	3,9
G	.100	--	2.54	--	4
H	--	--	--	--	5
J	.029	.045	.74	1.14	8
K	.028	.034	.71	.86	--
L	.009	.125	.23	3.18	--
M	.1414 Nom		3.59 Nom		6
N	.0707 Nom		1.90 Nom		6

- NOTES:
1. Metric equivalents (to the nearest .01 mm) are given for general information only and are based upon 1 inch = 25.4 mm.
 2. Measured in the zone beyond .250 (6.35 mm) from the seating plane.
 3. Measured in the zone .050 (1.27 mm) and .250 (6.35 mm) from the seating plane.
 4. Variations on dimension B in this zone shall not exceed .010 (.25 mm).
 5. Outline in this zone is not controlled.
 6. When measured in a gaging plane .054 +.001, -.000 (1.37 +.03, -.00 mm) below the seating plane of the transistor maximum diameter leads shall be within .007 (.18 mm) of their true location relative to a maximum width tab. Smaller diameter leads shall fall within the outline of the maximum diameter lead tolerance. Figure 2 preferred measured method.
 7. All leads shall be electrically insulated from the case.
 8. Measured from the maximum diameter of the actual device.
 9. All 3 leads.

FIGURE 1. Physical dimensions of transistor type 2N428 (TO-5).



LTR	DIMENSIONS			
	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.1409	.1419	3.58	3.60
B	.0702	.0712	1.78	1.81
C	.182	.199	4.62	5.05
D	.009	.011	.23	.28
E	.125 Nom		3.18 Nom	
F	.054	.055	1.37	1.40
G	.372	.378	9.45	9.60
H	.0350	.0355	.89	.90
J	.150 Nom		3.81 Nom	
K	.0325	.0335	.83	.85
L	.0595	.0605	1.51	1.54

NOTES:

1. The following gaging procedure shall be used: The use of a pin straightener prior to insertion in the gage is permissible. The device being measured shall be inserted until its seating plane is $.125 \pm .010$ (3.18 \pm .25 mm) from the seating surface of the gage. A spacer may be used to obtain the .125 (3.18 mm) distance from the gage seat prior to force application. A force of 8 oz \pm .05 oz shall then be applied parallel and symmetrical to the device's cylindrical axis. When examined visually after the force application (the force need not be removed) the seating plane of the device shall be seated against the gage.
2. The location of the tab locator, within the limits of dim C, will be determined by the tab and flange dimension of the device being checked.
3. Metric equivalents (to the nearest .01 mm) are given for general information only and are based upon 1 inch = 25.4 mm.

FIGURE 2. Gage for lead and tab location for transistor type 2N428.

TABLE I. Group A inspection

Examination or test	MIL-STD-750		LTPD	Symbol	Limits		Unit
	Method	Details			Min	Max	
Subgroup 1			10				
Visual and mechanical examination	2071			---	---	---	---
Subgroup 2			5				
Breakdown voltage, emitter to base	3026	Bias cond. D; $I_E = -25 \mu\text{Ade}$		BV_{EBO}	-20	---	Vdc
Breakdown voltage, collector to emitter	3011	Bias cond. D; $I_C = -1 \mu\text{Ade}$		BV_{CEO}	-12	---	Vdc
Breakdown voltage, collector to base	3001	Bias cond. D; $I_C = -25 \mu\text{Ade}$		BV_{CBO}	-30	---	Vdc
Collector to base cutoff current	3036	Bias cond. D; $V_{CB} = -1.5 \text{ Vdc}$		I_{CBO}	---	-.3	μAde
Emitter to base cutoff current	3061	Bias cond. D; $V_{EB} = -1.5 \text{ Vdc}$		I_{EBO}	---	-.3	μAde
Subgroup 3			5				
Base emitter voltage (nonsaturated)	3066	Test cond. B; $V_{CE} = -0.25 \text{ Vdc}$; $I_B = -1 \text{ mAde}$		V_{BE}	---	0.45	Vdc
Base emitter voltage (nonsaturated)	3066	Test cond. B; $V_{CE} = -0.35 \text{ Vdc}$; $I_B = -10 \text{ mAde}$		V_{BE}	---	-0.8	Vdc
Collector to emitter voltage (saturated)	3071	$I_C = -200 \text{ mAde}$; $I_B = -10 \text{ mAde}$		$V_{CE}^{(\text{sat})}$	---	-0.25	Vdc
Forward-current transfer ratio	3076	$V_{CE} = -0.25 \text{ Vdc}$; $I_B = -1 \text{ mAde}$		h_{FE}	60	250	---
Forward-current transfer ratio	3076	$V_{CE} = -0.35 \text{ Vdc}$; $I_B = -10 \text{ mAde}$		h_{FE}	20	---	---
Small-signal short-circuit forward-current transfer-ratio cutoff frequency	3301	$V_{CB} = -.5 \text{ Vdc}$; $I_C = -1 \text{ mAde}$		f_{hfb}	10	---	MHz
Base-spreading resistance	---	$V_{CB} = -.5 \text{ Vdc}$; $I_C = -1 \text{ mAde}$; $f = 2 \text{ MHz}$ (see figure 3)		r_b	---	160	ohms
Open-circuit output capacitance	3236	$V_{CB} = -.5 \text{ Vdc}$; $I_E = 0$; $100 \text{ kHz} \leq f \leq 1 \text{ MHz}$		C_{obo}	---	20	pf
Subgroup 4			10				
Switching parameters:							
Turn-on time	3251	Test cond. A; $R_B = 6,900 \text{ ohms}$ (see figure 4)		t_{on}	---	.85	μsec
Turn-off time	3251	Test cond. A; $R_B = 6,000 \text{ ohms}$ (see figure 4)		t_{off}	---	1.10	μsec
Subgroup 5			10				
High-temperature operation:		$T_A = +70^\circ\text{C}$					
Collector to base cutoff current	3036	Bias cond. D; $V_{CB} = -1.5 \text{ Vdc}$		I_{CBO}	---	-70	μAde
Forward-current transfer ratio	3076	$V_{CE} = -0.25 \text{ Vdc}$; $I_B = -1 \text{ mAde}$		h_{FE}	50	---	---

TABLE I. Group A inspection - Continued

Examination or test	MIL-STD-750		LTPD	Symbol	Limits		Unit
	Method	Details			Min	Max	
Subgroup 5 - Continued							
Low-temperature operation:		T _A = -55°C					
Forward-current transfer ratio	3076	V _{CE} = -0.25 Vdc; I _B = -1 mAdc		h _{FE}	45	---	---

TABLE II. Group B inspection

Examination or test	MIL-STD-750		LTPD	Symbol	Limits		Unit
	Method	Details			Min	Max	
Subgroup 1			20				
Physical dimensions	2066	(See figure 1)		---	---	---	---
Subgroup 2			15				
Solderability	2026			---	---	---	---
Thermal shock (temperature cycling)	1051	Test cond. B except T (max) = +100°C		---	---	---	---
Thermal shock (glass strain)	1056	Test cond. A		---	---	---	---
Moisture resistance	1021			---	---	---	---
End points:							
Collector to base cutoff current	3036	Bias cond. D; $V_{CB} = -30$ Vdc		I_{CBO}	---	.25	μ Adc
Emitter to base cutoff current	3061	Bias cond. D; $V_{EB} = -20$ Vdc		I_{EBO}	---	.25	μ Adc
Forward-current transfer ratio	3076	$V_{CE} = -0.25$ Vdc; $I_B = -1$ mAdc		h_{FE}	60	250	---
Subgroup 3			20				
Shock	2016	Nonoperating; 500 G, 1 msec; 5 blows in each orientation: X_1 , Y_1 , Y_2 and Z_1		---	---	---	---
Vibration, variable frequency	2056	10 G		---	---	---	---
Constant acceleration	2006	20,000 G; in each orientation: X_1 , Y_1 , Y_2 , and Z_1		---	---	---	---
End points: (Same as subgroup 2)							
Subgroup 4			20				
Terminal strength (lead fatigue)	2036	Test cond. E		---	---	---	---
End points:							
Seal (leak-rate)	1071	Test cond. G or H for fine leaks ; test cond. A, C, D or F for gross leaks		---	---	1×10^{-7}	atm cc/sec

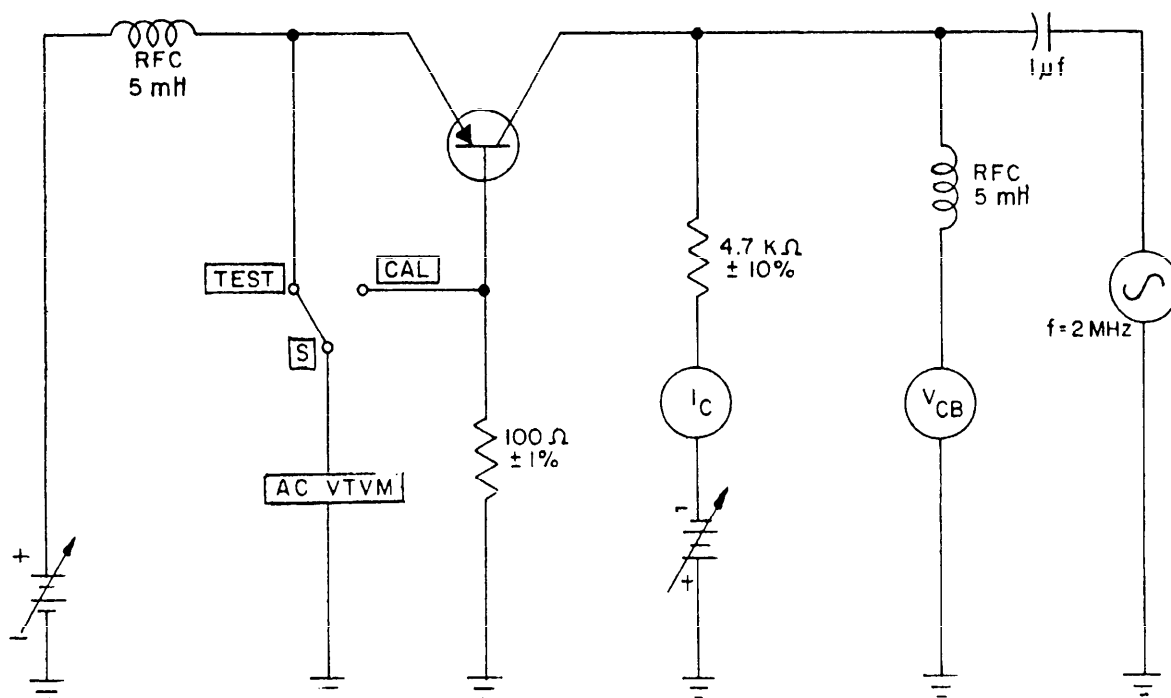
TABLE II. Group B inspection - Continued

MIL-S-19500/44D

Examination or test	MIL-STD-750		LTPD	Symbol	Limits		Unit
	Method	Details			Min	Max	
<i>Subgroup 5</i>			20				
Salt atmosphere (corrosion)	1041			---	---	---	---
End points: (Same as subgroup 2)							
<i>Subgroup 6</i>			5				
High-temperature life (nonoperating)	1032	$T_{\text{sig}} = +100^{\circ}\text{C}$; time = 340 hours (see 4.3.4)		---	---	---	---
End points:							
Collector to base cutoff current	3036	Bias cond. D; $V_{\text{CB}} = -30\text{ Vdc}$		I_{CBO}	---	40	μAde
Emitter to base cutoff current	3061	Bias cond. D; $V_{\text{EB}} = -20\text{ Vdc}$		I_{EBO}	---	40	μAde
Forward-current transfer ratio	3076	$V_{\text{CE}} = -0.25\text{ Vdc}$; $I_{\text{B}} = -1\text{ mAde}$		h_{FE}	42	300	---
<i>Subgroup 7</i>			5				
Steady-state operation life	1027	$T_{\text{A}} = +25^{\circ}\text{C}$; $V_{\text{CB}} = -15\text{ Vdc}$; $P_{\text{T}} = 150\text{ mW}$; time = 340 hours (see 4.3.4)		---	---	---	---
End points: (Same as subgroup 6)							

TABLE III. Group C inspection

Examination or test	MIL-STD-750		LTPD	Symbol	Limits		Unit
	Method	Details			Min	Max	
<i>Subgroup 1</i>			$\lambda = 7$				
High-temperature life (nonoperating)	1031	$T_{\text{sig}} = +100^{\circ}\text{C}$ (see 4.3.4)		---	---	---	---
End points: (Same as subgroup 6 of group B)							
<i>Subgroup 2</i>			$\lambda = 7$				
Steady-state operation life	1026	$T_{\text{A}} = +25^{\circ}\text{C}$; $V_{\text{CB}} = -15\text{ Vdc}$; $P_{\text{T}} = 150\text{ mW}$ (see 4.3.4)		---	---	---	---
End points: (Same as subgroup 6 of group B)							



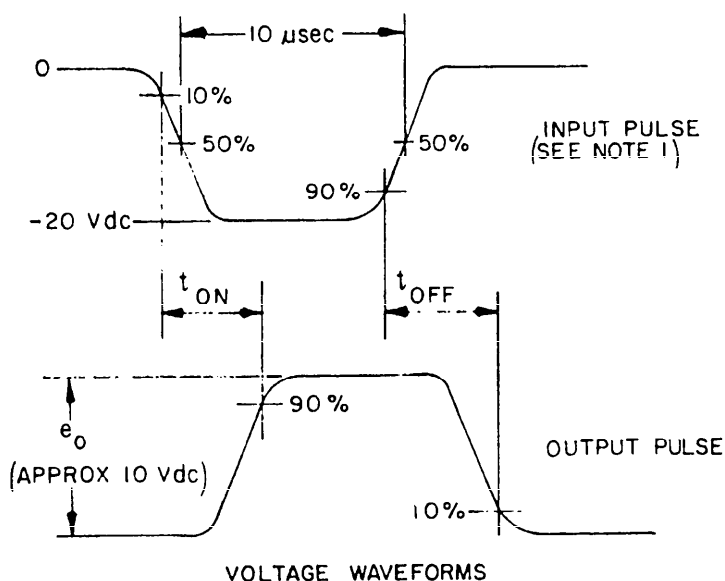
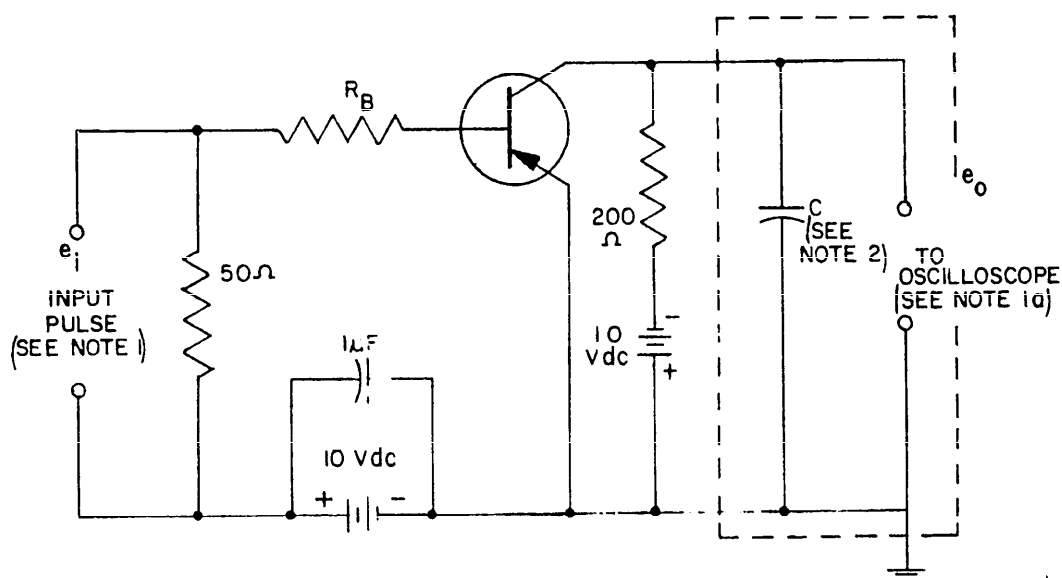
NOTES:

1. Test computation shall be based upon the following formula:

$$r_b = 100 \times \frac{\text{Reading of AC VTVM with switch S in test position}}{\text{Reading of AC VTVM with switch S in CAL. position}} - 100$$

2. An equivalent test circuit may be used.

FIGURE 3. Base spreading resistance (r_b) test circuit.



NOTES:

1. Input pulse:
 - a. The rise and fall times of the input pulse and the oscilloscope used to view the output voltage should be less than $0.03\text{ }\mu\text{sec}$.
 - b. Repetition rate = 500 Hz.
2. Oscilloscope and wiring capacitance = 15 pf.
3. An equivalent test circuit may be used.

FIGURE 4. Test circuit and waveforms for measuring t_{on} and t_{off} times.

4.3.2 *Group B inspection.* Group B inspection shall consist of the examinations and tests specified in table II.

4.3.3 *Group C inspection.* Group C inspection shall consist of the examinations and tests specified in table III. This inspection shall be conducted on the initial lot and thereafter every 6 months during production.

4.3.4 *Group B and group C life-test samples.* Samples that have been subjected to group B, 340-hour life-test, may be continued on test to 1,000 hours in order to satisfy group C life-test requirements. These samples shall be predesignated, and shall remain subjected to the group C 1,000-hour acceptance evaluation after they have passed the group B, 340-hour acceptance criteria. The cumulative total of failures found during 340-hour test and during the subsequent interval up to 1,000 hours shall be computed for 1,000-hour acceptance criteria.

4.4 *Methods of examination and test.* Methods of examination and test shall be as specified in tables I, II, and III.

5. PREPARATION FOR DELIVERY

5.1 See MIL-S-19500, section 5.

6. NOTES

6.1 *Notes.* The notes specified in MIL-S-19500 are applicable to this specification.

6.2 *Ordering data.* Procurement documents should specify the following: Terminal-lead length if other than specified in figure 1 (see 3.3.1).

Custodians:

Army - EL
Navy - EC
Air Force - 85

Review activities:

Army - MU, MI
Navy - SH
Air Force - 11, 17
DSA - ES

User activities:

Army - SM
Navy - CG, MC, OS, AS
Air Force - 13, 15, 19, 70, 80

Preparing activity:

Army - EL

Agent:

DSA - ES

(Project 5961-0158)